DOCUMENT RESUME

ED 352 363 SP 034 251

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TITLE Integrating Teachers' Career Development and Professional Development: The Science Education Professional Development Project.
PUB DATE Apr 92
NOTE 32p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, April 20-24, 1992).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Career Development; *Faculty Development; Foreign Countries; *Inservice Teacher Education; Locus of Control; *National Norms; National Surveys; *Policy Formation; Professional Associations; Professional Recognition; *Science Teachers; Secondary Education; Status Need
IDENTIFIERS *Australia; Knowledge Base for Teaching; Reform Efforts; Science Education Research

ABSTRACT

This paper describes the Science Education Professional Development Project in Australia, charged with the development of a national strategy for enhancing professional development of science teachers. Interviews were conducted with senior policy officers, science teachers' associations and unions, and 80 science teachers in 12 secondary schools. Concerns were voiced about the status of teaching, teacher morale, and recent recruits into science teaching; a weak sense of professional community and professional standards; lack of career structure based on knowledge and skills; the changing basis of control over professional development and professional standards; the in-service education system; and the locus of authority over the professional knowledge base of teaching. Based on the interviews, a strategy was developed which included award restructuring, integration of professional and career development, and strengthening of the professional community of science teachers. Appendices present tables of contents listing professional development resources for science departments; and professional standards for the teaching of science: an exploration of what advanced skills science teachers should know and be able to do. (Contains 37 references.) (LL)

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ED352363

Integrating Teachers' Career Development and Professional Development

The Science Education Professional Development Project:

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Integrating Teachers' Career Development and Professional Development

The Science Education Professional Development Project:

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The Science Education Professional Development (SEPD) Project was commissioned by the Commonwealth Department of Employment, Education and Training (DEET) as part of its Projects of National Significance Program. Its brief was to develop a national strategy for enhancing the professional development of science teachers.

Background to the Project:

There was growing concern during the late 1980s about the declining attractiveness of science courses at the tertiary level and science related careers, especially science teaching. The academic quality of students who gained entry to such courses also seemed to be declining, much to the alarm of university science faculties. There was also concern also about the quality and morale of science teachers in high schools and evidence that teachers were advising students against careers in science and science teaching. Teaching ranked fourth among twenty occupations in terms of beginning salaries, but fifteenth after five years(Chapman, et al., 1991). .

The Discipline Review of Science and Mathematics Teacher Education (DEET, 1989) provided a national appraisal of the quality of initial training for science and mathematics teachers in Australian colleges and universities. This influential report drew attention to the need to improve the quality of science learning in schools, and to enhance the social relevance and gender inclusiveness of science education generally, including that provided in universities. The review also highlighted the limited science background and training of most people entering primary teaching.

Australia was starting to share the concerns about the future of teaching itself as an occupation that had given the Americans such a scare in the early 1980s (National Commission of Excellence in Education, 1983; Carnegie Forum on Education and the Economy, 1986), and which had led the OECD to initiate its activity on *The Condition of Teaching* (OECD, 1989). There was concern about teacher morale (Hull, 1990), the ageing of the profession, the declining ability of teaching to attract abler recruits (NBEET, 1990), and the loss of many able teachers to alternative careers. Any national strategy for the professional development of science teachers that did not address these issues about the condition of teaching risked being irrelevant.

During the 1980s there was also growing concern about the future of the Australian economy and its international competitiveness. Reports such as *Australia Reconstructed* (1987) emphasised the need for a more scientifically and technologically literate and proficient

citizenry. In the past, Australia had been called the 'lucky country' because it was able to rely so heavily on natural resources and primary industries in international trade. As markets for these commodities weakened significantly during the 1980s, Australians were exhorted to become the 'clever country', or the 'the 'intelligent' country.

Australia Reconstructed contained comparisons with several more economically successful OECD countries. One of its main conclusions was that Australia needed to place much more emphasis on the on-going value of "skills formation" in the workforce. This priority led to the reform of industrial awards covering wages and conditions in all industries. 'Award Restructuring', as it was to be called, was a strategy that involved reviewing existing pay classifications to establish skill-related career paths that encouraged workers to participate in continuing skill formation.

This strategy became embodied in 'The Structural Efficiency Principle' a decision laid down by the Industrial Relations Commission of Australia in 1988. This principle emphasised the need for "a more highly skilled and flexible labour force to assist in structural adjustment and to provide workers with access to more varied, fulfilling and better paid jobs." As we shall see, Award Restructuring had profound implications potentially for the teaching profession. In the past, teachers and most occupational groups expected salary increases to be tied to changes in the cost of living. The only career paths for teachers were out of teaching. It was not at all clear how concepts such as productivity and 'skill-related career paths' could be, or shouldbe, applied to teaching.

Developing a Strategy

The brief for the SEPD Project gave no detailed specifications about the nature of the professional development strategy that was expected. At first we viewed the task in terms of developing an innovatory in-service education course for science teachers; one that might be repeated across the nation, as the successful Early Literacy In-service (ELIC) Courses had been for thousands of primary teachers. This would also require a considerable investment in a 'train the trainers' program to prepare school system consultants to provide such programs. It did not take us long to see that the economic conditions in the mid-1980s that favoured the development of long term in-service programs such as ELIC, no longer applied. (Nearly 40,000 teachers completed ELIC courses between 1985 and 1990 at a cost of more than $20m to Commonwealth and State Governments.)

We came to see the task more in terms of policy analysis, defined by Wildavsky (1979) as the creation and crafting of problems worth solving. The more relevant task was to assist policy formation by defining more clearly what the problem was that needed to be solved in the first place. In other words, our priority shifted to understanding better what the problem was that the strategy for the professional development of teachers needed to address.

Assessing the need: What were the key problems a national strategy should address?

There would be many different ways of conducting a policy analysis in this area; of creating or crafting a problem worth solving, as Wildavsky suggests. Our time and resources were

limited, so major surveys of student views and current science teaching practice had to be ruled out. We relied where possible on existing research in these areas. However, we did think that the task of clarifying the problem that the strategy should address would be assisted by gathering data from the following sources:

(a) Interviews with senior policy officers in each state education authority with responsibility for science curriculum about what was currently provided for science teachers, and what was needed from their point of view.

We asked about the most promising forms of in-service education they were operating and attempted to ascertain current levels of investment by state authorities in the in -service education of their science teachers. The process of trying to gather this data was itself a saga revealing often less than satisfactory human resource management practices, with little coordination between curriculum and professional development sections of the bureacracy, and few professional development activities designed in such a way that they could actually help teachers to improve the quality of their practice. All states were found to be reducing activity in this area, and encouraging more of the initiative to be taken up by teacher/subject associations, a move that many of the latter viewed with a jaundiced eye.

(b) Interviews with science teachers' associations and unions in every state.

We asked them to help us clarify factors currently affecting the quality of science teaching and the implications for a strategy. We were always surprised at the strength of feeling that emerged in these discussions about the declining status and recognition afforded to teachers. Close links were developed with the Australian Science Teachers Association during the project, and we collaborated in carrying out a survey of all the state science teachers' association activity. These discussions also explored future, expanded roles for these organisations as professional associations in the usual sense of that term: organisations that offer leadership in terms of establishing standards for practice, what counts as quality practice, as well as procedures for accrediting advanced levels of practice and recognising contributions to professional knowledge and practice.

(c) An interview study based on eighty science teachers in twelve secondary schools across Australia.

The interviews concentrated on areas such as their attitudes to their work, their sense of career, their workplace, their science department, their views on what helped or hindered them doing their jobs as well as they would wish, their professional development, teacher evaluation, their approach to teaching science, and the impact of recent system-level policy. These interviews aimed to understand contextual influences on teachers' work through the eyes of science teachers themselves. This study is reported in detail in Ingvarson & Loughran (1992).

This early work on the SEPD Project lead us to believe that our strategy needed to address a broader range of concerns and a wider policy agenda than the development of better in-service education courses alone.

The status of teaching

We repeatedly heard concerns about the status of teaching, teacher morale, and recent recruits into science teaching. A disturbingly high proportion of science teachers said they had little sense of having a career as a science teacher, would not choose to go into teaching if they had their time over again, and actively discouraged their students from science related careers. They thought that their work was important to society, but misunderstood and largely unappreciated.

It was becoming clearer that we needed to redefine the problem that a strategy should try to address. Was the problem something to do with the provision of in-service education courses, or was it more fundamentally something to do with the diminishing attractiveness of science teaching as a career? And, was there some connection between the impotence or irrelevance of in-service education for most of the teachers we interviewed and the fact that the career structure itself placed little value on advances in their knowledge and skill? Had a career structure that rewarded more those who taught less and less subtly undermined self esteem amongst teachers Had it undermined confidence in the value of their work and the complexity and sophistication of their own best practices developed over many years? Had it limited their willingness to claim a specialised knowledge base for their work expressible through codified professional standards?

We came to see that there was not much point in designing very good in-service courses unless there was also a fundamental shift in the whole "economy" of the in-service education system and how it related to teachers' careers; the way it was governed and by whom, the way its goals and purposes were determined (the knowledge base), and the incentives (career rewards) for engaging in it.

We were coming to believe that these were largely matters of professional concern and that the locus of authority concerning them should rest with the profession itself. If the occupation started to take collective responsibility for these matters we might have the seeds of a strategy that could enhance both the status of teaching and the impact of in-service education.

Our interpretation of the interviews we had with science teachers was that we were looking at an occupational group that was, in the main, committed and competent, but relatively powerless. These teachers had a weak sense of professional norms and identity, and low self esteem. There was little pressure for discussion or consensus about what counted as quality science learning or teaching; you 'did your own thing'. When asked how they evaluated their own teaching, teachers referred to intuition and personal values, rarely corporate professional standards or norms.

Weak sense of professional community and professional standards

We coined the term "loose connections" to convey this milieu of isolation and detachment from a sense of professional community at all levels; from the school science department

level to the national science teacher association level. Many of these science teachers had a weak professional identity in the sense that they were loosely connected with:-

- other teachers and opportunities for genuinely shared work (collegiality)
- in-service education and other forms of support (professional development)
- scientists and wider science activity generally in society (science)
- frequent and accurate feedback about their performance (evaluation)
- a sense that their work "made a difference" (efficacy)
- their professional/subject associations (professional identity)
- professional standards, norms and ethics (accountability)
- a sense of getting better at their work (career development)
- regular intimations of respect from administrators, parents, community (recognition and status)

This interpretation reflects the isolation of teachers from a range of potentially beneficial influences on their work. The corollary is that these science teachers exercise little collective responsibility over matters with the potential to lift the professionalism and status of teaching. The image of teachers that emerged was their powerlessness.

The loose connections are in two related domains. One is associated with the lack of recognisable or demonstrable reference points or professional standards in science teaching. These represent weak organisational controls over teachers' work This has its "up side" - a sense of autonomy. But it seems to be a false sense of autonomy. The "down side is that science teachers as a group exercise little power over a range of "professional" issues that have the potential to provide them with greater status and a stronger skill-related concept of career development.

Although teachers had considerable discretion at the classroom level, they had few opportunities to exercise corporate control over a wide range of "professional" matters. Nor did they appear to expect that they should have. For example, none of the teachers we interviewed had participated in discussions about the criteria that were to be used for evaluating teachers for Advanced Skills Teacher (AST) status. None were surprised that they had not. But when we talked further about who should be involved in setting standards for science teaching it did not take them long to come to the view that they had a right to be involved.

Teaching is remarkable, among occupations requiring similar levels of training and professional judgment, for the lack of participation of its members in decisions affecting standards of entry, tenure, advanced qualifications and promotion in their own profession. Maybe one of the legacies of one hundred years of centralised state bureacratic control over teaching in Australia is the fact that teachers are habituated to feeling that the responsibility always rests elsewhere, with "them" or "The Department". The profession had been infantilised.

Lack of a career structure based on knowledge and skill

Teaching has been characterised by a divorce between career development and professional development; between promotion and further qualifications, or evidence of 'advanced skills'. One of the main reasons for this divorce is the lack of a professional consensus about a knowledge base for teaching; a consensus about what science teachers should know and be able to do based on 'best practice" and research.

It is a characteristic of most professions that career advancement is based on payment for the person, for their *knowledge and skill*. It is a characteristic of bureaucracies that the pay system is based on payment for the job or payment for occupying a position in an organisational hierarchy. Extra pay for teachers in state schools beyond the basic scale has traditionally followed the bureaucratic model; extra pay for extra duties and responsibilities, not extra pay for enhanced knowledge and skill or expertise.

Academics, in contrast, have a pay system based in principle on knowledge and skill. There are several career development steps: lecturer, senior lecturer, reader, and professor. For teaching there has been one classification only. In essentials, the career steps for academics do not represent different jobs or different work. At all levels, academics are expected to make a contribution to teaching, research, administration, and the wider professional community. The pay system is based on expertise, not extra duties. This pay system is apparently associated with many of the more effective companies in the USA (Lawler, 1990; Peters, 1987). It is difficult to see any compelling reason for maintaining such a fundamental distinction between the career structures for academics and teachers.

Lack of professional control over professional development and further qualifications

The formal award system for advanced professional qualifications (diplomas and degrees, etc.) in teaching is currently controlled by another institution, the universities, unlike most other professions. On the face of it there appears to be no clear reason why this should continue to be the case indefinitely, nor any obvious reason why teacher organisations should not set up their own system for advanced professional awards, as many other professions do. Although they provide many excellent degrees and diplomas for teachers, universities provide few opportunities to teacher organisations or employing authorities to participate in decisions about the content and methods of courses for advanced qualifications they provide for their members.

Science teachers associations, for example, have had little formal participation in decisions about the nature and content of degrees and diplomas specifically directed at their members. There are some indications that this situaton is changing with the development in some states of "consortia" between employers, universities and teacher associations to organise the provision of in-service courses for credit for teachers. Whether teachers will become senior partners in these consortia remains to be seen.

The changing basis of control over professional development and professional standards.

We found that school systems were withdrawing from their traditional role as the major providers of subject-focused professional development programs external to the school. This was increasing the pressure on other in-service education providers such as subject associations. Independent providers were emerging and charging fees to cover their costs, a break from previous practice for course provided by employing authorities. Some universities were expanding their role dramatically in the non award area as well, making the unsubstantiable promise in some cases that their in-service education courses would prepare teachers for promotion to AST status.

However, there was still a strong expectation amongst teachers and their professional associations that employers should be the main providers of funding and programs for their professional development. Strong resentment was expressed to the SEPD Project by science teacher association representatives about what was seen to be an abdication by state systems of their responsibility for maintaining and enhancing the quality of education. Equal concern was expressed by science policy officers from state systems whose leadership role and capacity to meet science teachers' requests for support had been circumscribed significantly or abolished as a result of administrative restructuring.

The question now was whether teachers' organisations, such as the science teachers associations and the unions, would continue to mourn the abdication of responsibility by employing authorities, or whether they would take the opportunity to establish their own training and development system based on standards for quality practice established by the profession itself, and formally linked to career development stages from registration, through to Advanced Skills Teacher (AST) levels to be introduce under Award Restructuring.

The in-service education system

Within any school system there are several interdependent dimensions that link to form an in-service education 'system'. They are:

The *governance* or decision-making structure. We look to this for answers to questions about *who* is exercising control over funds and making decisions that legitimise particular activities. We seem to have moved to a situation where the governance system is more diffuse or dispersed, with Commonwealth funds for professional development being channelled directly in part to schools. The overall level of government funding for professional development has fallen steadily over the past fifteen years. The governance system in most states is clearly no longer a tightly coupled system. dominated by teacher education branches within school system bureaucracies.

The *knowledge* system is the second dimension. We look to this system for answers to questions about *what* is learned by teachers and how it is learned. Every ISE activity represents a claim about what teachers should know. Where does this knowledge come from? How is it generated? Who decides that it is legitimate knowledge?

The governance system decides, at least implicitly, what teachers should learn, and how. What seems to characterise the knowledge system is not so much its dispersed nature as the absence of much discussion about it at all. There has been little analysis leading to confidence about what constitutes professional 'development'. Teachers are provided with a smorgasbord of mostly unrelated in-service activities over the years rather than a planned sequence of experiences and activities designed to provide them with a skills-related career path and to help them attain a high standard of practice, validated by their peers, embodied, as we shall see, in the original concept of the Advanced Skills Teacher.

The third is the *incentive* system. What are the mechanisms for recognising and rewarding teachers for advances in their knowledge and skill? This returns us to the issue raised earlier; the lack of relationship in teaching between evidence of professional development and career development. The incentive system is almost non-existent in any formal or official sense . There are no rewards, for example, in terms of salary loadings or career, for a science teacher going on to complete a masters degree, in some field of science, related to their teaching.

The locus of authority over the professional knowledge base of teaching

We may also be in a transition period so far as the locus of authority about professional knowledge in teaching. Who decides what teachers need to know and be able to do? What counts as valid knowledge about teaching? From where does this knowledge come? In other words, who determines what the main goals for our investment in professional development will be?

In theory at least, it is possible to distinguish three sources of goals for professional development activity: government policy, educational research and theory, and teacher needs or interests. In practice these categories overlap considerably. Innovation in a school system may be *policy-driven*, as with integration for example; or, it may be *theory-driven*, as with process writing and early literacy courses; or, it may be *user-driven*, where teacher networks, for example, meet to share their own ideas and experience.

Although the categories overlap, they do serve to draw our attention to issues of control and authority over professional knowledge. They also draw attention to the primary purposes that are served by the in-service education system. Our survey of employing authorities indicated that they had retreated to a system that was largely policy-driven and inadequate to meet the full range of demand for quality in-service education opportunities by science teachers.

This contraction in employer provision, though regrettable, provided an opportunity to make a shift in the locus of authority over professional knowledge and the evaluation of teaching; from what Strike (1990) calls "bureaucratic democracy" to "professionalism".

> The ethical context of evaluation for the ideal types of bureaucratic democracy and professionalism differ. The former is dominated by the assumption that teachers owe a duty of loyalty to externally determined goals and policies and to an organisation that hires them to implement these goals and policies; and that in turn the organisation owes them a duty of fair treatment. In the professionalism model,

> teachers when they are engaging in their professional activities, owe their loyalty to clients, to professional standards and to the profession. (p. 366)

Strike goes on to point out some of the implications of going down the professionalisation route to reform .

> First, the professionalisation of teaching requires a significant erosion of bureaucratic democratic authority over teaching practice. Second, professionalism is likely to result in significant restructuring of the management of educational organisations. Finally, the argument that teaching is a profession depends very substantially on the claim that there is an esoteric body of knowledge in which the practice of teaching is grounded and that there are suitable professional norms for the regulation of practice. (p. 366)

One of the emerging purposes of the SEPD was to explore the validity of this claim; whether or not we should decide to go down the professionalism path as a means of reforming teaching and enhancing the status, income and working conditions of teachers.

Summary

We seemed to be at an indeterminate stage with respect to the locus of authority over a range of professional matters in Australia. Bureaucratic controls between legislative authority and the work of teachers are weak and have been weak for many years since the demise of inspection. But also, little control is exercised over teachers' work through professional ethics, norms and standards. As our interviews of science teachers for the SEPD Project illustrated, teachers as an occupation are "loosely connected". The corollary of this was that, as an occupation, teachers are relatively powerless over professional matters such as their own professional development and the in-service education "system" - factors that contributed indirectly to the self-esteem and status of teachers. There were few rewards or incentives for improvement in knowledge and skill. The pay system said, implicitly, that teaching was not a career after about eight to nine years of automatic salary increments.

Teachers essentially lead a hand-to-mouth, subsistence life in relation to opportunities for ideas, professional development, and collegial interaction. We found that over seventy-five percent of the science teachers we interviewed had participated in one day at most of science related in-service courses over the previous two years. Professional development goals and priorities were determined more by the need to inform teachers about government policy shifts than developments in educational knowledge or theory about the learning and teaching of science. There was a lack of attention to science content, or 'pedagogical content knowledge' (shulman, 1987) in system-provided PD. The latter was being left more and more to subject associations.

Many of the in-service courses that were provided were 'one-off' activities and were, therefore, a poor implementation of what is known about effective methods of ISE; i.e. there were few serious programs with the potential to actually help teachers add to their professional knowledge and skill

Both the opportunity and the extrinsic rewards for engaging in professional development were limited.

Developing A Strategy

It was clear from the interviews we conducted with science teachers across Australia that the quantity and quality of current opportunities for their professional development fell far short of what was required to sustain, let alone improve, the quality of teaching. The gap made science teachers deeply cynical about the rhetoric of a "clever country". They saw themselves as key players in realising such a vision, but as yet uninvited, certainly not enticed, to join the game.

It also became clear that we had two major questions that had to be addressed if any strategy was going to have a chance of widespread and penetrating effect.

The first problem was the low morale amongst science teachers. This was related in part to the lack of mechanisms for giving status or recognition in career terms for demonstrable improvements in practice. The extrinsic reward or incentive system was weak.

The second problem was the finding that there was little consensus or clarity about what science teachers were expected to get better at. There was no clear direction or purpose for long-term professional development policy and planning. Without clarity in this area, the concept of career development made little sense. Despite years of pronouncements about the importance of professional development, there was little agreement about the dimensions along which teachers might be expected to develop or improve in terms of knowledge and skill. Professional development provision, as experienced by teachers, was mainly random and directionless in terms of career development

We knew quite a lot about how to provide effective in-service education courses for teachers. Shortage of knowledge in that area was not a problem. However, shortage of investment to put this knowledge into practice certainly was. We argued that no strategy for professional development stood much chance of widespread success without parallel improvements in:

(i) our structures for giving recognition in career terms for demonstrable improvements in practice, which in turn were dependent on;

(ii) the validity of our methods for the evaluation of teaching, which in turn were dependent on,

(iii) the soundness of the knowledge base about quality teaching and learning we use when evaluating teachers for promotion.

We needed to move on these three fronts as well to develop a credible career structure for recognising and rewarding advanced levels of expertise in teaching if our professional development efforts were to engage the majority of teachers. One potentially powerful opportunity for achieving this was currently provided by Award Restructuring in teaching.

Award Restructuring

As outlined in the introduction, the origins of Award Restructuring rest with *Australia Reconstructed*, a national report on the future of the Australian economy and its international competitiveness. The "Structural Efficiency Principle", introduced by the Australian Industrial Relations Commission in 1988, amounted to using industrial awards as a lever for workplace reform, taking them beyond areas such as wages and conditions into areas traditionally regarded as managerial prerogative (Curtain, 1991). Pay classifications and basic conditions of employment were to be reviewed to establish skill-related career paths.

It was not immediately obvious how Award Restructuring could be applied to teaching. Teacher organisations were sceptical of the concept of 'productivity' in education. After much negotiation, the industrial parties eventually agreed to introduce the concept of the "Advanced Skills Teacher" (AST), an additional series of three career steps for practicing teachers that would take them to a salary equivalent to that of a deputy principal. This new classification was designed to link career development more closely with demonstrable outcomes of professional development. It aimed to give a career structure for classroom teachers who found the administrative career ladder less appealing than professional practice.

For teachers, this "Award Restructuring" and the new Advanced Skills Teacher (AST) classification meant the introduction of more tangible incentives for professional development than in the past, at least in theory. It was hoped that career development and professional development would thereby be integrated.

Not so readily acknowledged, Award Restructuring also meant that the teaching profession had to introduce a system of teacher evaluation. Unlike the USA, where teacher evaluation is a very common feature of the educational landscape, most teachers in Australia now only experienced some form of evaluation, after gaining registration (a license to teach), if they applied for promotion. Strike action and administrative reorganisations had seen the demise of the "Inspector" in most school systems by the 1980s.

Award Restructuring meant that unions and employers would have to learn how to set standards of practice that represented advanced knowledge and skill. However, the guidelines on award restructuring were vague on how standards should be arrived at, and who should be involved in establishing them. Much work also needed to be done on how teacher evaluation could be carried out in a valid, credible and fair way. There was an extensive overseas literature on teacher evaluation and the acute complexities involved in implementing such a sensitive innovation, but only limited attention was being given to its warnings by the industrial parties involved in planning for the introduction of the ; especially those related to the necessary lead-in time, the cost, and the need for broad-based consultation and discussion across the profession.

Award Restructuring appeared to have the potential to reduce teachers' concerns about status, and the lack of recognition and reward in career terms for demonstrable advances in teaching skill.

A strategy for integrating professional development and career development

The strategy developed by the SEPD Project fell into two main, interdependent areas:

1. Strengthening the "Professional Community" of science teaching

Our interpretation of our research was that we needed a strategy to strengthen the role of the professional community among science teachers at all levels; at the school science department level, across schools at the district level, and at wider levels such as state and national science teachers associations.

2. Strengthening the relationship between professional development and career development.

There was a need to create a better career structure for practising science teachers, one that gave greater incentives and recognition for demonstrable improvement in the quality of practice. For this to happen we needed to shift to a pay system more closely geared to paying for knowledge and skill. The concept of skills-based *career development* as a teacher needed to be institutionalised as an alternative to the traditional bureaucratic career ladder model based on payment for occupying a position (Bacharach, Conley & Shedd, 1990; Lawler, 1990; Odden & Conley, 1991).

Award Restructuring offered the SEPD Project a golden opportunity to develop a professional development strategy with some 'bite'. We have talked for years about the need to give recognition to teachers for demonstrable advances in the quality of practice as a result of in-service education, but with little real progress. We have talked for years about 'professional development' but also with surprisingly little clarity about the major directions and dimensions for this 'development'.

1. Strengthening the "Professional Community" of science teaching

Professional communities

Teachers belong to a variety of professional communities. These communities include subject departments or faculties, teams of staff working with particular groups of students, the whole staff of their school, and wider groups at state and national levels, such as unions and subject associations.

At the school and department level, students benefit when teachers have built up shared values and professional norms, when there is a strong sense of collegiality and plenty of opportunity to plan and review work together, and where there is a strong commitment to norms of continuous improvement and evaluation of departmental offerings to students (Little, 1982, Rowan, 1991, Bryk & Driscoll, 1988). These are some of the main characteristics of professional communities. Underneath the idea of professional community is the acceptance of a degree of mutual accountability and peer review of practice (Darling-Hammond, 1986).

At the wider level, professional community means that teachers' organisations take up responsibility for establishing a knowledge base for teaching and standards for quality practice to be applied at various stages in a teachers' career, such as registration, permanency and promotion to positions such as Advanced Skills Teacher.

(a) The science department as a professional community

The SEPD Project team developed a set of resources called *Where Do We Start?: Professional Development Resources for Science Departments?* The table of contents for this report is in Appendix 1. These materials and ideas for in-service activities were aimed at science teachers who wanted to make their workplace and regular science department meetings to be as much an opportunity for sharing ideas and professional activities as they were a time for routine adminstrative matters. These resources aimed to strengthen the professional development role of science department chairs.

Potentially, the workplace is one of the most important avenues for a teacher's professional development. But in many schools this potential is not realised. There is little enough time and energy to carry out essential duties. Traditionally schools have not been organised as if they might be places where teachers learn, as well as students. We tried to develop resources that could be integrated with regular departmental meetings as much as possible.

The trend toward school-based staff development has been strengthening in recent years. But the whole school staff is often too diffuse and unwieldy a group for effective learning. The individual subject department is one of the most important arenas for activity within a school's in-service education program. As science teachers often have to teach topics outside their main area of subject competence, there is, or there should be, a high level of interdependence in science departments. Teachers need each other's expertise to cope effectively with a diverse science curriculum. In-service activities at the department level have a greater chance to focus on the details of practice, because of shared interests; and in a way that is more likely to lead to change in what teachers do.

For most secondary teachers their own subject department is the fundamental professional unit or workgroup. It is the natural home for the regular professional and social interaction about the details of teaching and learning that is essential for the development and sustenance of a professional culture. It is therefore the most potent unit for mutual influence, professional development activity, and the implementation of change. But it can also be an instrument of complacency, and for resisting change. (Little, 1991)

One of the significant aspects of the Advanced Skills Teacher (AST) concept is that it has the potential to give clearer purpose and direction to professional development planning in the science department. It gives teachers something to aim at over the long term. Without quotas, it gives members of the science department professional development goals or standards that they can help each other to attain. Quotas on such career development positions are totally inconsistent with the concept of the AST.

For schools that have staff appraisal schemes, their long term goal would be to help teachers attain the quality of practice embodied in the AST standards. Many schools seemed not to have made this link between appraisal, or formative evaluation, and summative evaluation of teachers for promotion to AST status, but it is a vital one.

The link between professional development and career development would thereby be strengthened, which was the main point of in the first place. One of the main ways in which it was hoped intended Award Restructuring would achieve its aims was by encouraging greater collegiality in the workplace directed to on-going 'skills formation' and evaluation of the quality of practice (Bluer & Carmichael, 1990).

(b) Trialling the development of a case literature of quality science teaching and learning.

As another approach to strengthening the professional community, we trialled the development of a "case literature" (Shulman, 1987) of quality science teaching and learning. We wanted to test the idea of establishing a tradition of on-going documentation and validation of exemplary practice amongst science teachers, and a vehicle for giving status and recognition to their professional knowledge. This work is reported in the SEPD Project report *Windows On Science Teaching: Case Studies of Practice.*

The aim of this component of the SEPD Project was to strengthen professional networks across schools to increase the access of science teachers to each other's best ideas. The rationale behind the development of this type of resource for professional development was simply that teachers valued other teachers' ideas and experience more highly than many other source of help. We felt that more should be done to formalise and celebrate the value of teachers' practical knowledge.

Two related perspectives informed this work. One was the growing attention that was being given to the question of the knowledge base of teaching, within the context of "professionalising" teaching (Eg Shulman, L. 1987a; Sykes, 1991). This perspective aims, in part, to give greater recognition to the expertise and "practical knowledge" that many teachers gain as a result of experience. The second was the related growth in interest in the use of cases in teacher education in recent years (Eg Carter, 1988; Barnett, 1991; Shulman, J., 1987). Cases appear to be promising ways to represent knowledge about teaching in a form that makes it accessible for learning, action and reflection by others. They provide alternative assumptions, to those which underpin traditional modes of in-service education, about where knowledge about teaching comes from, how it is represented, and how teachers learn.

Cases come in a variety of forms and are used for a variety of teaching purposes. Our cases attempted to document the pedagogical content knowledge of experienced science teachers in a form that made it accessible for trial and reflection by other teachers. Similar work has been done in mathematics in the Mathematics Curriculum and Teaching Project (MCTP) by Lovitt, Clark and Clark. (1990).

The cases are not simple vignettes of a single lesson, but the outcome of several deliberate stages from initial idea, trialling, observation, documentation, retrialling by other teachers, discussion and evaluation, re-drafting, and retrialling. The cases attempt to build in and make explicit the pedagogical reasoning that lies behind the teacher's method. Reflective comments are included at each key stage in the activity to help achieve this. The experiences and suggestions of other teachers who implement the activity are also added to the case. In a sense, the cases are never finished because there are always more insights and ideas that emerge as others use them.

We have trialled several different methods for developing the cases. No one knew how best to do them. So we looked on the task as one of sending out a flotilla of trial methods in the hope that some would turn out to be successful. We established one group of high school teachers from a cluster of local schools with an consultant who set about documenting and trialling ideas. We were particularly interested also in bringing science teachers into contact with practicing scientists to develop "cutting edge" teaching activities. Another tack was to offer payment to individual teachers to send us drafts of teaching ideas, and we paid other teachers to trial and evaluate these. This brought more interest than we could adequately handle in the time available to the SEPD Project, but we hoped that others, such as the Australian Science Teachers Association, might take up the task and eventually establish a self-funding tradition of documenting quality practice. A bank of case studies would provide teachers with a way to make a contribution to professional knowledge.

The cases were intended for use in a wide variety of pre- and in-service teacher education situations. Teachers can, of course, read and use them alone, but the major benefits come through situations where groups of teachers are using and reflecting on the activities.

(c) Strengthening the corporate professional role of the Science Teachers Associations in association with teacher unions.

The Australian Science Teachers Association and its state level affiliates play an important role for their members (six thousand, out of a potential membership of about twenty thousand) in providing services such as conferences, publications, inservice courses and fellowship. But they are essentially voluntary bodies. As they are neither unions nor employers, they have no access the industrial relations arenas to represent their membership directly over work conditions or professional matters such as standards for the training, licensing, and tenure of science teachers. We came to believe that there were considerable potential benefits to strengthening the "professional" role of subject associations such as ASTA, in collaboration with teacher unions, in a wide range of policy and delivery areas, particularly the establishment of professional standards to be used in any plans for career restructuring. The unions needed the expertise that subject associations could mobilise to set credible professional standards. The subject associations needed the unions if their professional role was to be enhanced.

As indicated above, there were a number of reasons for believing that there was the potential for the inservice education system to undergo a fundamental change from a bureaucratic to a

more professionally controlled model. The capacity of the school system authorities to provide support and to control the in-service education system was in decline due to the recession and various waves of administrative restructuring. However, this retraction was happening at the same time as the federal government was encouraging reforms such Award Restructuring to lift the general participation of the workforce in on-going "skills formation" and to provide career paths based on this expansion in knowledge and skill; reforms that were fundamentally dependent on lifting the quality and amount of in-service education and training for teachers.

Needed: a national professional body

If ASTA was to play a stronger role enhancing the professional community and helping to shape quality practice it would require the development of an umbrella independent professional body, such as a national teaching council, to have oversight of the processes of setting standards, accrediting courses for teachers, and establishing validated procedures for the evaluation of teachers applying for advanced certification. Such a body might have the clout to ensure that Award Restructuring was implemented across employing authorities in a way that bore some resemblance to its original aspirations.

The immediate policy and delivery areas where the Australian Science Teachers Association and its state level affiliates could play an important role seemed to be as follows:

- delineating a knowledge base for science teaching and establishing performance standards for what science teachers should know and be able to do at major points in their careers.

- using these standards to develop a range of teacher assessment methods to be used in evaluating teachers for career advancement to positions such as the Advanced Skills Teacher.

- establishing expectations for the role of science department chairs in developing more collegial professional communities within schools that take collective responsibility for peer review and quality control.

- establishing a tradition for the documentation of quality practice funded out of regular sales of documented cases to science teachers; and supported by giving formal recognition to teachers who thereby make a contribution to the professional knowledge base of science teaching.

- encouragement of the Australian Science Teachers Association to develop a stronger capacity to act as a provider of professional deveopment activities itself that contribute to advanced certification of teachers. Such a project would require 'seed' money before becoming self funding.

- the provision of in-service education courses to science teachers that are designed over the long term to assist teachers to reach designated professional standards

- accreditation of other providers of professional development for science teachers such as universities and professional development 'consortia'..

The main vehicle through which ASTA could play this enhanced role professional role would be through participation in the work of the proposed National Teaching Council for Australia - a new professional body for teachers, independent of union and employer, with these proposed objectives

- to support improvements in the quality of teachers' work
- to maintain and improve professional standards, and
- to provide public support and advocacy for the profession.

Under the auspices of a National Teaching Council, the Australian Science Teachers Associations could be engaged in a number of roles and projects concerned with pre-service education, induction, professional development, professional recognition, and educational leadership.

The need for a knowledge base

Critical to most of the above functions is the capacity of the profession to learn how to establish professional development standards and valid methods for teacher evaluation. The need to clarify what science teachers should get better at has also been sharpened recently by Award Restructuring.

It seems obvious that our professional development strategy would have to be based on some kind of professional consensus about what science teachers needed to get better at. Yet when we surveyed the field of science education we found that few attempts had been made to articulate such goals, goals that would help to give direction and purpose to science teachers' professional development over the long term, or even the short term of, say, the first ten years of their careers.

The SEPD Project recommended that a national project should be initiated to establish professional standards to be applied at various stages of science teachers' careers. A body such as the proposed national teaching council would need to work with specialist subject associations and teacher unions to clarifying the knowledge base of teaching across the full range of curriculum areas.

The SEPD Project initiated a pilot project in this area and its work was reported in *Professional Standards For the Teaching of Science: An Exploration of What Advanced Skills Science Teachers Need To Know and Be Able To Do*. This exercise was a first attempt to articulate a knowledge base for the teaching of science. It aimed to provide an indication of how much work would be involved in a full scale exercise of developing standards and a professional evaluation system for science teaching. Leading science educators were asked to select one facet of what counted for them as quality learning in science. They were then asked to address the question of what an advanced skills science teacher should know and be

able to do in order to foster that learning (The table of contents for this report is in Appendix 2.)

Even though the *Standards* report was only a beginning, it did show that the knowledge and skill that underpins best practice in science teaching can be highly complex and sophisticated. This meant that any proposed teacher evaluation system for career advancement must be capable of reflecting this complexity. The report also served the purpose of showing that the knowledge base for science teaching is much more extensive than many science teachers realise, because we have rarely tried to articulate and codify its extent. Because it has not been codified, teachers themselves have tended to underestimate, and lack confidence in, the extent of their own specialist knowledge; knowledge about how to teach particular scientific concepts, about how students learn science, about how to plan curricula, about how to probe student understanding, and much more.

The *Standards* report raises more questions than answers. It is still not clear that we can establish a professional consensus for standards for the teaching of science. What should a 'standard' look like for teaching anyway? How should we represent knowledge about teaching? The papers in this report suggest that standards are best represented through 'cases' of teaching, rich 'stories' that illustrate the context of quality practice. But we are a long way from anything that could be considered a comprehensive coverage of standards for science teaching.

Authors were also asked to suggest valid procedures for giving recognition to the complexity and sophistication of quality science teaching and learning And, given the complexity of teacher knowledge, who had the expertise to carry out assessments of teachers' work for AST status in a valid and fair manner? It was clear that there must be multiple forms of evidence, a view consistent with other commentators (e.g. Scriven, 1989) and that ideas for teacher assessment such as performance exercises and portfolios, as described by Haertel (1991) and Bird (1990), were worth exploring further. It was also clear that these methods would require assessors who had expertise in the subject field because assessments would rely heavily on professional judgment.

The point was emphasised by all contributors that it takes many years of professional development and reflection on experience to acquire this professional knowledge. Any pre-service training course can only be a beginning.

2. Aligning professional development with career development

It is widely recognised that we need a new conception of a career structure appropriate to teaching. It has to be one peculiarly suited to the nature of teaching and the context of teachers' work, not one based, as in the past, on a bureaucratic model of management.

Career structures must be judged primarily in terms of their impact on the quality of students' opportunities to learn (Sykes, 1990).The necessary characteristic of any new structure we design must be that it keeps the best and brightest of our teachers close to students, encumbered as little as possible with non-educational, administrative duties. This requires a

pay system and an organisational design wherein status and prestige are tied closely to those characteristics which are most central to a school's ability to achieve its purposes; the quality of teaching. Award Restructuring is the best opportunity we have at the moment for aligning careers in education much more closely with the central objectives of the education system and schools - quality learning and teaching.

In principle, Award Restructuring, through the introduction the Advanced Skills Teacher classification (AST), aims to improve the quality of education by providing career rewards to teachers for demonstrable advances in their *professional* knowledge and skills. To achieve this "productivity" aim there must be a clear link between professional development and career development. Such a link between career and quality of practice can only be forged if three conditions are met:

(i) we are confident that we know what the main dimensions of knowledge and skill are that teachers should get better at. These provide directions and standards for professional development known to be related to what our community values as quality learning;

(ii) we are confident that we have valid evaluation methods for recognising when a teacher's practice has reached the quality represented by the standards set out in (i); and

(iii) the public is prepared to pay for a career structure that is based on these professional standards. In other words, a pay system that values knowledge and skill. This is only likely to happen, we believe, when the teaching profession takes on, as its own responsibility, the long term task of developing such standards and evaluation methods.

Award Restructuring in Practice (So far)

The second arm of the SEPD strategy aims to strengthen the incentives for professional development,. It depends on Award Restructuring being implemented in a way that it is consistent with its original intentions.

Award Restructuring has the potential to be one of the most important reforms we have seen in Australian education because it central aim is to place greater value on teachers' knowledge and skill. It thus goes to the heart of what is needed to redress recent concern about the condition of teaching as an occupation. It is not a merit pay scheme, nor is it a career ladder concept. However, the idea of paying teachers more simply for being better teachers in terms of professional standards, not for doing extra work or duties, seemed to be bizarre to some, another legacy of the idea that teachers simply occupy a bureaucratic role.

At the end of the first year of its implementation, there were few signs that a link between professional development and career development was being forged. Promotion to AST status had little or no relationship to evidence of professional development, nor the achievement of standards of practice defined by professonal consensus. (See Chadbourne & Ingvarson, 1991) This was primarily because of fundamemtal weaknesses in the criteria that were established for AST positions and the school-based panel procedures that had been developed for evaluating applicants for AST positions.

Standards and selection procedures

In the state of Victoria, union leaders and employers agreed on the following set of selection criteria for AST.

A. Skills in effective teaching practice and reporting and evaluating student progress.

B. Positive relationships with students and their classes and effective communication skills when collaborating with parents and other teachers.

C. Awareness of current trends and developments in education.

D. Knowledge of current Government policy in education.

E. Ability to develop ideas gained from professional developoment activities to enhance students' learning.

F. Contribution to the organisation, planning and development of curriculum.

G. Knowledge of and commitment to the development and implementation of Equal Opportunity/Social Justice strategies.

H. Knowledge of the Action Plan for Women in the Teaching Service and a commitment to its implementation.

I. Capacity to assist other teachers in their professional development and the ability to supervise, instruct and counsel student teachers.

Applicants were provided with a form to complete which allowed half a page for them to demonstrate their capacity to meet each criterion. They were "advised not to exceed the space provided". Some guidelines were provided, although most simply restated what was in each criteria. For example, under criterion A applicants had half a page to demonstrate:

- consistent use of of a range of classroom procedures and teaching strategies in accordance with Ministry policies and school practices;
- thorough preparation and purposeful planning;
- use of a variety of assessments/evaluation/reporting procedures;
- effective classroom management which provides a classroom climate conducive to learning;
- use of non-discriminatory teaching practices;
- provision of assistance to students with specific educational needs.

The AST selection criteria as listed above represented quite reasonable expectations, except for those unfortunate criteria (G and H) that appeared to call for commitment to the policies of the particular government of the day, something that caused great resentment among many teachers. These have since been modified.

Most applicants were assessed by a school based panel which included the principal, a teacher nominated by and from the teachers in the school, a union representative from the school, and an employer representative, usually someone from the regional office, or an administrator from a nearby school.

However, when panels tried to use the criteria for AST 1 they realised that, in practice, the criteria were difficult to apply as 'standards', because the guidelines did not really indicate what counted as satisfying, or not satisfying them. It was as if panels were asked to evaluate cars on a dimension such as suspension without a clear idea of what was meant by 'suspension', and without the standards to help them judge what counted as good or poor suspension.

Panels had to satisfy themselves that applicants met all criteria using *only* (i) the evidence that applicants had written about themselves; (ii) reports providing substantiating evidence from three referees nominated by the applicant; and (iii) an interview of up to one hour, unless the panel reach a unanimous judgment based on the material provided by the candidate. Although strong arguments had been made for locating the procedures in the context of the school, where teachers would be known by their colleagues, the selection guidelines, in contradiction, stipulated that "Subjective judgments about an applicant's merit based on prior knowledge of the applicant are not to be made. To add a further bizarre note, it was often the case in practice that panel members were also referees who had, of course, to make use of prior knowledge in providing substantiating evidence.

Victorian State School teachers were invited to apply for AST1 positions in February 1991. About 19500 teachers were eligible, but only 65 % of these applied. Of those that applied, about 93% were successful. Few (less than 25%) were actually interviewed. Those that were asked to interviews tended to see it as a sign of failure.

The context at the time Award Restructuring was introduced.

There are many other reasons that have threatened the potential of Award Restructuring. These are discussed in detail in Ingvarson & Chadbourne (1992) and Ingvarson (1992). It is already apparent that career restructuring is threatened by the inevitable compromises of the industrial relations arena and an underestimation of the complexity of the task of developing standards and valid procedures for assessing teachers.

Many teachers and union leaders saw the AST position as just another step on the incremental pay scale - a pay rise justified by the inadequacy of existing salaries. As Angus (1991) points out "the general view of teachers (was) they were working harder, under greater pressure than ever before and, relative to other occupational groups, their earnings appeared to have slipped in real terms. Many teachers had been at the top of the incremental salary scale for many years.

It would be hard to think of less congenial circumstances in which to introduce such a complex reform than those which prevailed in 1991. The concept of the Advanced Skills

Teacher proved to be difficult to translate faithfully into industrial agreements and valid procedures for evaluating teachers. Here is a summary of some of the reasons.

• Most state governments found themselves facing a financial crisis. Partly as a result, quotas were imposed on AST2 and AST3 positions, thus undermining the career development rationale of AR. Also, these positions reverted to designated senior responsibility positions to be determined by the school, such as staff development or pupil welfare coordinator. Every school was given a fixed number of such AST positions. The number of ASTs in a school became, illogically, a function of the size of the school rather than the quality of performance of the staff members. Instead of paying teachers for knowledge and skill, the AST 2 & 3 positions have reverted to the bureaucratic career ladder model of paying for extra tasks and responsibilities.

• There was a massive backlog of eligible teachers (over 19000 in the state of Victoria alone). It was common to find over 50% of teachers in many schools applying. For example, over 68 applied in one secondary college; all were promoted without interview. This was a common experience. There were too many applicants to cope with using more thorough, but time-consuming, methods of teacher evaluation. The pressure was to establish routine, standardised procedures quickly.

• Training of panel members was reduced to a two hour run through the administrative side of the interview panel procedures. Little detailed training of panels in the application of the criteria was provided.

• Other major concurrent reforms, such as the Victorian Certificate of Education, a major curriculum and assessment change for high school graduation, drew heavily on resources, particularly teachers' time and energy.

• Teachers were very suspicious about the laying down of standards for AST without any specific employer commitment or planning to help teachers attain them. Despite the rhetoric of skills formation, no discernible steps were taken to reorganise professional development planning or provision to relate it more closely to the AST classification.

Union leadership has been hesitant to take on more rigorous methods of standard setting and teacher evaluation, thereby undermining the need to provide a career path based on advanced skill, and a means of lifting self-esteem and the status of teaching. A predisposition to protect individual members may undermine union capacity to offer their membership that which is in the long term interest of teachers; a viable future for the profession itself. Little recourse was made to research and development in developing standards, especially the extensive research on teacher evaluation (e.g. Millman & Darling-Hammond, 1990). No trials were carried out on the validity of the criteria and the procedures before applying them to make important decisions about the careers of many thousands of teachers.

Discussion

It is clear that the strategy proposed by the SEPD Project rests on a very shaky foundation at present. But Award Restructuring is the 'only game in town' with the potential to provide a professional career structure for teachers. Award Restructuring can only fulfil this potential if teacher organisations claim the responsibility for establishing valid standards and credible systems for teacher evaluation as their own.

It also depends on unions and employers reaching agreements about the AST positions that stick to the original goals of Award Restructuring: giving teachers a career path based primarily on advances in their knowledge and skill, as an alternative to careers based primarily on moving into management, or undertaking extra duties and responsibilities. The present danger is that award restructuring will be implemented in a way that does not promote a career development perspective. Current procedures for teacher evaluation are being used for dual and incompatible purposes: to meet the needs of the individual in career recognition terms, and the needs of the schools to staff themselves to ensure that administrative duties are covered. Some employers are using the AST positions to draw teachers to schools that are hard to staff .

The establishment of a National Teaching Council has considerable potential for institutionalising a career structure based on knowledge and skill through a new form of advanced certification of teachers, related perhaps to the AST. Such a council could institutionalise procedures whereby unions and other teacher asssociations, such as the Australian Science Teachers Association, worked together on the development of professional standards and assessment procedures to be used in assessing teachers for advanced certification in each of the various teaching specialisms. These certificates could be used when teachers apply for AST status to their various employers. Such a procedure could certainly enhance the range of evidence and the validity of the evaluation methods currently used by school-based panels.

The aims forAward Restructuringwill not be achieved unless the method of evaluation of teachers for the AST classification is credible, valid and reliable. That is the foundation stone for the success of the enterprise. Give what has happened so far in Victoria, the evaluation system has to be declared invalid. Financial restrictions are a significant part of the reason. By definition,Award Restructuringcan not be cost neutral. But if the success rate for AST 1 had been, say, 50% instead of over 90% it would have cost the employers less and it would have benefitted the teaching profession more in terms of public credibility and self esteem.

But even if the financial climate had been more benign, AR, as currently conceived, would not have been able to achieve its stated objectives. The procedures for evaluating teachers for AST 1 positions in Ministry of Education have been introduced very quickly, without enough research into what it takes to develop and implement a valid and credible system. The Americans, for example, estimate that it will cost well over $50m and take 10-15 years to fully implement their newly established National Board for Professional Teaching Standards (Baratz-Snowden, 1991). We need a similar time scale and investment. We have

created the career structure before the standards and evaluation methods are in place, the reverse of the Americans; and it looks as if we will pay a price in terms of teacher frustration and enhanced cynicism.

We need to admit that as a profession we are inexperienced about how best to articulate what counts as good practice. We do not know how to represent standards of quality practice yet. The process of learning how to do this needs to embrace a much wider cross-section of the profession than it has done so far to capture the necessary expertise and in order to create a stronger sense of ownership for the standards. Many teachers who have been through the AST1 selection process in Victoria think that it is easy to meet the AST 1 criteria; they do not think that many of the criteria are valid or appropriate indicators of advanced skill, and they do not feel that the AST evaluation process provides them with opportunities to demonstrate their teaching skill. They are loosely connected, not professionally engaged by the whole process. They are not yet saying "This is *our* business".

The important thing about evaluation criteria is that they indicate what is valued. The criteria for AST can help to specify what it is that teachers are expected to get better at in their field of expertise - a direction for professional development. The greatest threat at the moment to realising the aims of Award Restructuring in the workplace is that teachers do not see a link between career development and professional development - under the present conditions, AST status will not be perceived as providing a standard to aim at over the first ten years or so of one's career as a teacher.

The AST classification does not as yet represent a professional consensus about what a primary teacher needs to get better at, say, in using literacy profiles; or what a secondary science teacher needs to get better at in fostering interpretive discussion to link new concepts with prior experience. Once teachers do not see a nexus between gaining the AST position and demonstrable improvements in knowledge and skill, the whole rationale of Award Restructuring for increasing "productivity" is nullified. Its potential to provide the engine for changes in work organisation will be lost.

AR is a powerful strategy with the capacity to improve the quality of teaching and professionalise the occupation. It is vital to treatAward Restructuringas an experiment - an innovation, not a manifesto set in stone. This perspective draws our attention to the extensive research on the management of change, the desirability of assuming that we are most unlikely to get such a complex reform right the first time, and the need to avoid dogmatism and recrimination when we do not.

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Appendix 1

WHERE DO WE START? PROFESSIONAL DEVELOPMENT RESOURCES FOR SCIENCE DEPARTMENTS

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Appendix 2

PROFESSIONAL STANDARDS FOR THE TEACHING OF SCIENCE
An exploration of what Advanced Skills Science Teachers should know and be able to do

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